Jan. 12, 1926.

1,569,370

E. HILL

ROTARY COMPRESSOR

Filed May 13, 1925

2 Sheets-Sheet 1

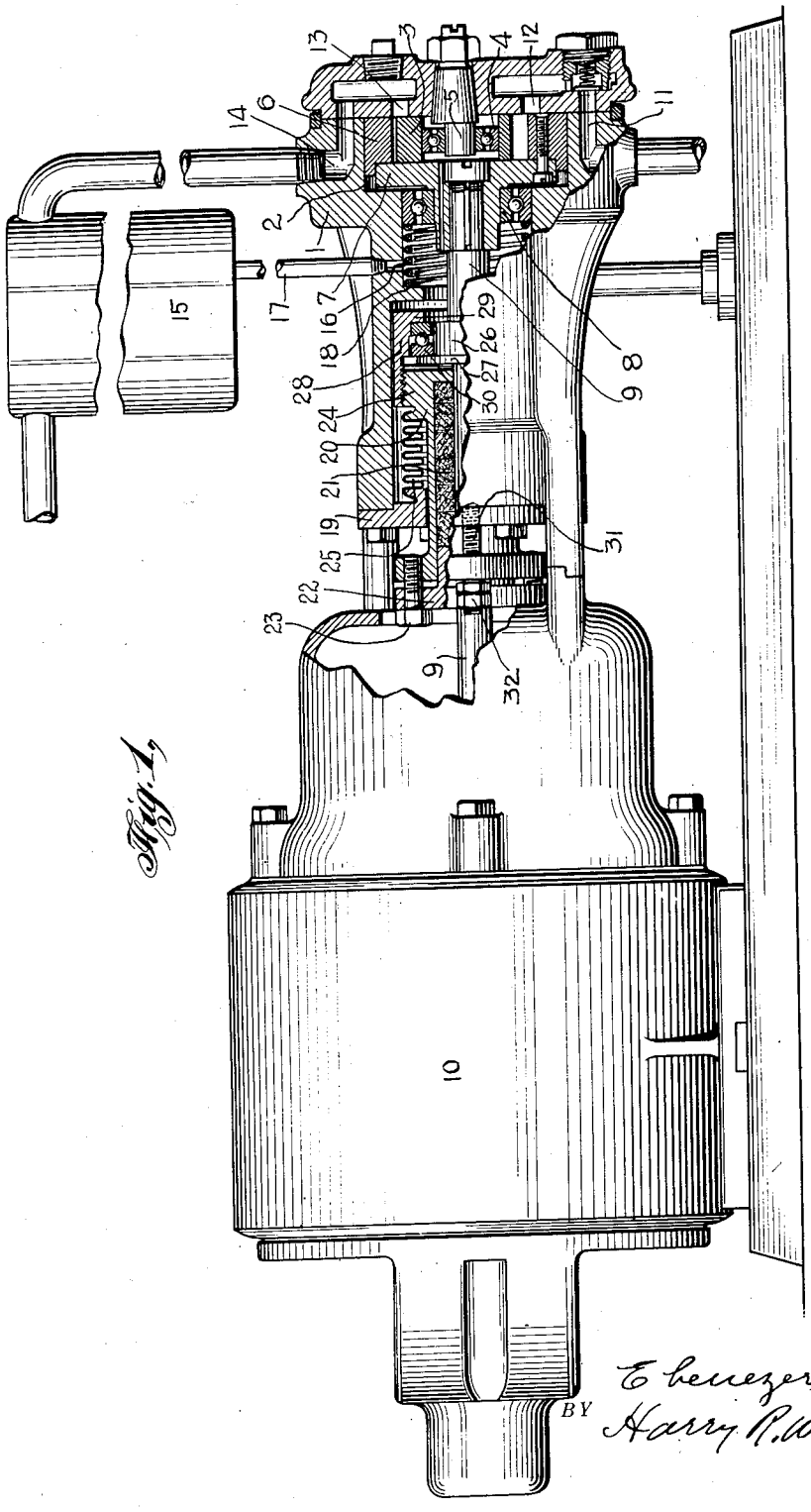

Fig. 1.

INVENTOR

Ebenezer Hill

BY Harry P. Williams

ATTORNEY

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Fig. 2.

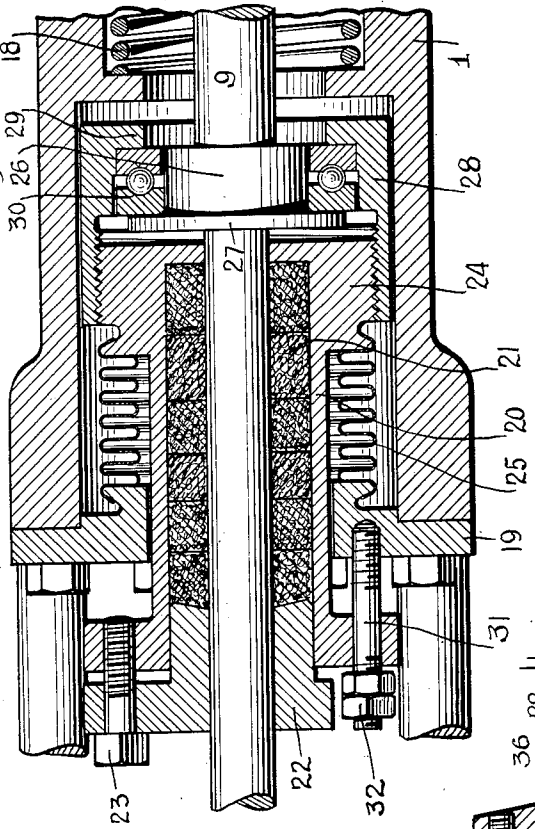


Fig. 4.

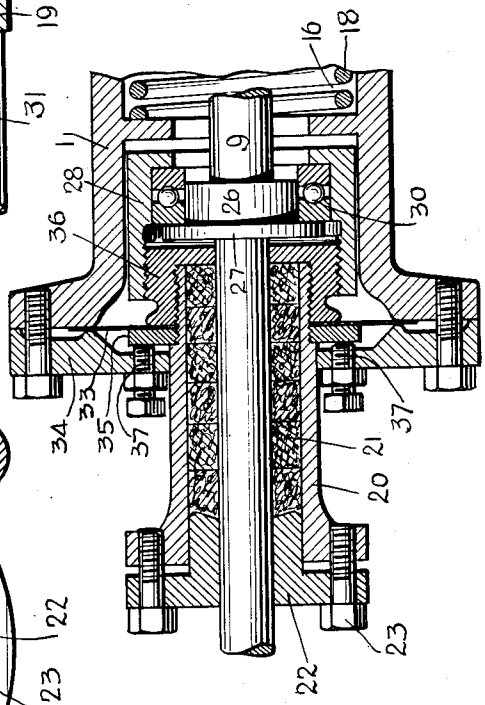
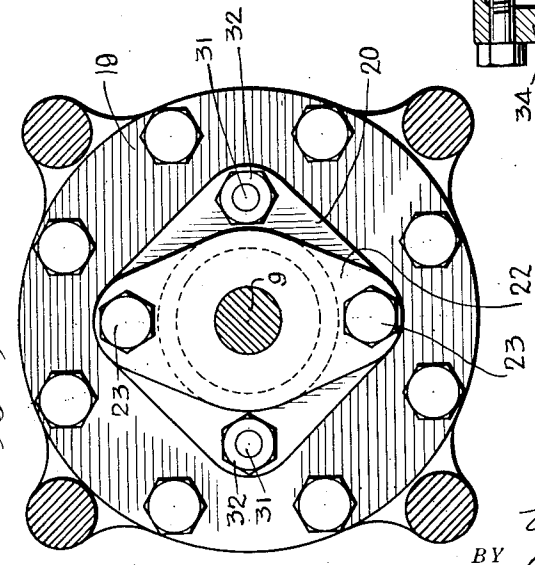


Fig. 3.



INVENTOR
Ebenezer Hill
BY Harry R. Williams
ATTORNEY

Patented Jan. 12, 1926. 1,569,370

UNITED STATES PATENT OFFICE.

EBENEZER HILL, OF SOUTH NORWALK, CONNECTICUT, ASSIGNOR TO THE HILL COMPRESSOR & PUMP COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

ROTARY COMPRESSOR.

Application filed May 13, 1925. Serial No. 29,907.

To all whom it may concern:

Be it known that I, EBENEZER HILL, a citizen of the United States, residing at South Norwalk, in the county of Fairfield and State of Connecticut, have invented a new and useful Improvement in Rotary Compressors, of which the following is a specification.

This invention relates to rotary fluid pumps and compressors and more particularly to the type which have an externally toothed pumping gear in mesh with a surrounding internally toothed pumping gear, the gears having a different number of teeth and arranged one eccentric with relation to the other, and one gear being motor driven so as to drive the other and cause the spaces between the engaging teeth to expand and contract as the gears rotate to effect the desired pumping or compressing, or exhausting action on the air, gas, liquid or other fluid being handled.

The object of the present invention is to provide a pump of this character with means whereby the internal pressures are so controlled that while the pumping members are retained sufficiently tight to perform their function efficiently, the friction due to the pressure of the pumping members against the faces of the casing is relieved to such an extent that the starting load and also the running load is materially reduced, thus enabling an electric motor of lower power to be used for operating the pump than has previously been considered possible. A further object is to so design the elements which attain the above result that the driving shaft packing aligns itself with the shaft even should the shaft be slightly out of line, which eliminates exact fitting and at the same time ensures tight joints and long life for the packing.

This object is obtained by arranging the stuffing box, containing the packing about the driving shaft, so that it is capable of both longitudinal and transverse movements in a recess in the casing back of the pumping members, the recess being in communication with a part of the apparatus on the discharge side of the pump in order that discharge pressure may be exerted in the recess and on the back of the pumping members. The floating stuffing box is retained in position by a flexible metal packing in the shape of a bellows, or sylphon, as such is commonly known, or in the form of a yielding diaphragm. One end or edge of the flexible packing is hermetically connected with a fixed part of the casing while the other end or edge is hermetically attached to the head of the stuffing box so that this packing forms a part of the wall of the recess and prevents leakage of pressure therefrom. The stuffing box is so connected with the driving shaft that the collapse or outward movement of the flexible packing under the force of the discharge pressure in the recess tends to draw the shaft backward and pull the pumping members away from the front face of the casing, but this movement of the parts is limited to such an extent that the pumping members are not in fact drawn away from the face of the casing, but only relieved of the force of the discharge pressure on their backs, which otherwise would press them strongly against the face of the casing and cause undue friction with a consequent increase of load on the motor used to drive the pump. The driving shaft is also capable of a slight independent movement longitudinally of the stuffing box.

In the accompanying drawings Fig. 1 shows a side elevation of the apparatus with a portion of the compressor cut in section. Fig. 2, on larger scale, is a longitudinal section showing the driving shaft, floating stuffing box, flexible packing and the connections whereby the shaft is drawn back in such a manner as to relieve the frictional pressure of the pumping elements against the face of the casing, according to the degree of discharge pressure in the recess. Fig. 3 is an end elevation of what is shown in Fig. 2. Fig. 4 is a section showing a modified form of the flexible packing.

The apparatus illustrated is of the type set forth in U. S. Patents No. 1,505,707, August 14, 1924 and No. 1,516,591, November 25, 1924. The casing 1 has a cylindrical chamber 2, containing the internal pumping member 3 which is rotarily mounted on bearings 4 supported by the stud 5, and containing the external pumping member 6 that is fastened to the plate 7 which is rotarily mounted on bearings 8 and is keyed to the driving shaft 9. The driving shaft is connected to and is rotated by the motor 10, which may be a common type of electric induction motor. The shapes of the pumping members and the manner of their co-

action are not particularly described as they are fully disclosed in the above mentioned patents and are well known to those skilled in this art.

When the apparatus is running the fluid operated upon passes in through the intake 11 and port 12 to the expanding spaces on the intake side of the pumping members and passes out from the contracting spaces on the discharge side of the pumping members through the port 13 and discharge 14 to the reservoir 15. In the casing back of the pumping members is a recess 16 which is in direct communication with the back of the pumping chamber, and also in communication, through the pipe 17, with the reservoir. In this recess a light spring 18 is arranged to, through bearing 8, press the pumping members forward against the front face of the pumping chamber.

In the present improvement the pump casing is extended toward and attached to the motor casing and the recess back of the pumping members is continued in this extension, the end of which is closed by an annular plate 19 fastened to the end of the casing. The stuffing box 20 extends loosely through the annular end plate and contains the usual soft packing 21 and has the common follower 22 drawn to place by bolts 23. In the recess between the end plate 19 and the head 24 of the stuffing box is a flexible metallic packing 25. This packing is in the form of a bellows, or, as stated, in the nature of the so-called "sylphon". The ends of this packing are hermetically fastened to the end plate and to the head of the stuffing box so that the packing forms a part of the wall of the recess and prevents the escape of any fluid under pressure in the recess around the outside of the stuffing box. The flexible packing allows the piston to move in and out longitudinally according to the pressure in the recess and it also allows the stuffing box some movement transversely. It is customary to support the driving shaft in bearings near each end and where the stuffing box is rigidly held it must be accurately lined up with such bearings. With the flexible packing illustrated the stuffing box being free to move transversely, automatically aligns itself with the bearings without causing undue wear on the soft packing in the box.

Fluid pressure in the recess tends to collapse the flexible packing and force the stuffing box outward. On the driving shaft is a collar 26 with an outwardly extending flange 27, and fastened to the head of the stuffing box is a cap 28 with an inwardly extending flange 29. Between the flanged end of the cap, attached to the stuffing box, and the flange of the collar, fastened to the shaft, is a thrust bearing 30. By means of this connection the outward pull of the stuffing box, resulting from the collapse of the flexible packing under the force of the pressure in the recess, is transmitted to the driving shaft that is connected with the pumping members, and thus tends to draw the pumping members away from the front wall of the pumping chamber. The bearing 30 relieves the friction between the cap flange, which does not rotate, and the shaft flange, which does rotate, and sustains the thrust resulting from the tendency of the stuffing box to move outward.

To limit the collapse of the flexible packing and outward movement of the stuffing box and prevent them from drawing the pumping members so far from the front wall of the pumping chamber that they would not function, adjustable stops are provided. These stops may consist of screw studs 31 threaded into the plate 19, fixed to the end of the casing, and extending loosely through the flanged outer end of the stuffing box, outside of which the studs are provided with adjusting and locking nuts 32, as shown in Fig. 1. By adjusting these nuts the outward movement of the stuffing box may be accurately determined.

Instead of the bellows or sylphon flexible packing above described, the recess containing the inner end of the stuffing box may be closed by a flexible metallic diaphragm 33, as illustrated in Fig. 4. The outer edge of the diaphragm is clamped hermetically tight between the end of the casing and the annular plate 34 that is bolted thereto, while the inner edge of the diaphragm is hermetically clamped between a plate 35 and the head 36 screwed upon the inner end of the stuffing box. Screws 37 are turned through the end plate 34 against the plate 35 for limiting the outward movement of the stuffing box and consequently determining the amount of backward pull on the shaft and pumping members.

The driving shaft is capable of slight longitudinal movement independently of the stuffing box, the space between the thrust bearing 30 and the head 24 of the stuffing box having a little greater width than the thickness of the flange 27. The pumping members and shaft are normally pressed forward by the spring 18, which spring however has not sufficient tension to overcome the outward pull of the flexible packing and the stuffing box on the shaft.

During the normal operation of an air or gas compressor provided with the load relieving means herein described there may be atmospheric or higher pressure at the intake, and, of course there will be much higher pressure in the recess which is connected with the discharge side of the compressor. This higher pressure in the recess being exerted on the back of the pumping members tends to force them against the front face of

the pumping chamber and keep the joints tight. The discharge pressure is also exerted on the flexible packing and on the end of the stuffing box and this tends to draw back the shaft and pull the pumping members away from the front wall of the pumping chamber. If the compressor is stopped the same conditions exist for a short time and the excess pressure in the recess on the back of the pumping member forces the pumping members against the front wall of the pumping chamber so tightly that it would require a large amount of power to turn the shaft. Within a very short interval of time, however, owing to seepage over the joints, the pressure substantially equalizes on the front and back of the pumping members and thus the pumping members become practically balanced as to pressure in the pumping chamber. The discharge pressure is still effective on the end of the stuffing box and flexible packing, and as the pressures are balanced on the pumping members the discharge pressure against the end of the stuffing box and on the flexible packing tends to push out the box and collapse the packing and pull the pumping members away from the front wall of the pumping chamber. The stop screws are, however, adjusted so as to prevent the pumping members from actually leaving the front wall of the pumping chamber any substantial distance, they are set so that the shaft can only be pulled back sufficiently to relieve the friction which would otherwise result from the close contact of the pumping members against the front wall of the pumping chamber. When thus relieved the shaft may be rotated easily notwithstanding the degree of pressure in the recess, for the pull of the flexible packing and stuffing box is proportional to the pressure in the recess. With the friction of the pumping members against the front wall of the pumping chamber relieved, the motor will start easily and immediately run up to operating speed, and if it is an alternating induction motor at once get in step with the phases of the power supply. As the motor runs up to normal driving speed the pumping members gradually pick up the load and as soon as this takes place the pressure on the intake side is reduced thus again establishing the preponderance of pressure on the back of the pumping members which forces them against the front wall of the pumping chamber with such closeness that the joints will be tight and the compression of the air or gas resumed at the normal capacity of the compressor. The delayed loading up of the compressor, which has been described, and which results from the action of the flexible packing and longitudinally movable stuffing box, is of great advantage in that it permits the use of a much smaller motor—one cheaper to buy and more economical to run—for the same pressures than has been previously been found necessary to use. As a result of the use of the substantially floating stuffing box the packing in the stuffing box has a longer life, it is not necessary to compress the packing tightly, and this allows the shaft to run easier with less load on the motor with the consequent saving of power. By adjusting the stop screws the most efficient contact of the pumping members against the front wall of the pumping chamber may be readily obtained.

The invention claimed is:

1. The combination in a rotary compressor having a casing with a pumping chamber and recess communicating with the back of the pumping chamber, said pumping chamber containing internal and external coacting pumping members, of a driving shaft connected with the pumping members and extending through said recess, means for admitting discharge pressure to the recess back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, a floating stuffing box surrounding the shaft and extending into the recess, a flexible metallic packing surrounding the stuffing box and having one end hermetically connected with the casing and the other end hermetically connected with the stuffing box, and means connecting the stuffing box with the shaft and adapted to pull the shaft and pumping members away from the front wall of the pumping chamber under the force of the discharge pressure exerted in the recess on the end of the stuffing box and on said flexible packing.

2. The combination in a compressor of the character described, of a driving shaft connected with the pumping members, means for admitting discharge pressure to the back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, a longitudinally movable stuffing box surrounding the shaft, a flexible metallic packing surrounding the stuffing box and having one end fixed and the other end connected with the stuffing box, and means connecting the stuffing box with the shaft and adapted to pull the shaft and pumping members away from the front wall of the pumping chamber under the force of the discharge pressure.

3. The combination in a rotary compressor of the character described, of a driving shaft connected with the pumping members, means for admitting discharge pressure to the back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, a longitudinally and laterally movable stuffing box surrounding the shaft, a flexible metallic packing surrounding the stuffing

box and having one end fixed and the other end connected with the stuffing box, and means connecting the stuffing box with the shaft and adapted to pull the shaft and pumping members away from the front wall of the pumping chamber under the force of the discharge pressure.

4. The combination in a rotary compressor of the character described, of a longitudinally movable driving shaft connected with the pumping members, means for admitting discharge pressure to the back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, a floating stuffing box surrounding the shaft, a flexible metallic packing surrounding the stuffing box and having one end fixed and the other end connected with the stuffing box, and means connecting the stuffing box with the shaft and adapted to pull the shaft and pumping members away from the front wall of the pumping chamber under the force of the discharge pressure.

5. The combination in a rotary compressor of the character described, of a longitudinally movable driving shaft connected with the pumping members, means for admitting discharge pressure to the back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, a spring arranged to force the pumping members toward the front wall of the pumping chamber, a floating stuffing box surrounding the shaft, a flexible metallic packing surrounding the stuffing box and having one end fixed and the other end connected with the stuffing box, and means connecting the stuffing box with the shaft and adapted to pull the shaft and pumping members away from the front wall of the pumping chamber under the force of the discharge pressure.

6. The combination in a rotary compressor of the character described, of a driving shaft connected with the pumping members, means for admitting discharge pressure to the back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, a floating stuffing box surrounding the shaft, a flexible metallic packing surrounding the stuffing box and having one end fixed and the other end connected with the stuffing box, means connecting the stuffing box with the shaft and adapted to pull the shaft and pumping members away from the front wall of the pumping chamber under the force of the discharge pressure, and an anti-friction thrust bearing interposed between said means and the shaft.

7. The combination in a compressor of the character described, of a driving shaft connected with the pumping members, means for admitting discharge pressure to the back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, a floating stuffing box surrounding the shaft, a flexible metallic packing surrounding the stuffing box and having one end fixed and the other end connected with the stuffing box, means connecting the stuffing box with the shaft and adapted to pull the shaft and pumping members away from the front wall of the pumping chamber under the force of the discharge pressure, and an adjustable stop arranged to limit the amount of backward pull of the shaft and pumping members.

8. The combination in a rotary compressor of the character described, of a driving shaft connected with the pumping members, means for admitting discharge pressure to the back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, and collapsible hermetically tight means having one end fixed and the other end floating and connected with the shaft and subject to the action of the discharge pressure for counteracting the discharge pressure on the back of the pumping members.

9. The combination in a rotary compressor of the character described, of a driving shaft connected with the pumping members, means for admitting discharge pressure to the back of the pumping members whereby said pressure tends to force the pumping members against the front wall of the pumping chamber, and floating sealing means connected with the shaft and subject to the force of the discharge pressure in an opposite direction to the force of said pressure on the back of the pumping members.

EBENEZER HILL.